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STANDARD SPECIFICATION FOR COLD INSULATION OF VESSELS, PIPING AND EQUIPMENT

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Abbreviations:

ASTM :	American Society for Testing and Materials
DFT :	Dry Film Thickness
GI :	Galvanized Iron
IS :	Indian Standard
PIR :	Rigid Poly Isocyanurate
PUF :	Poly Urethane Foam
S.S. :	Stainless Steel
SWG :	Standard Wire Gauge

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1.0 SCOPE

This specification covers technical requirements and procedure for the application of self extinguishing type insulation PUF/PIR and Mineral Wool to vessels, equipments, heat exchangers, pumps, piping and instruments, in temperature range of (+)120°C to (-)110°C.

2.0 GENERAL REQUIREMENTS

2.1 Insulation shall be provided on all vessels, equipments, heat exchangers, piping and instruments etc. containing fluids or vapour, for which it is necessary to :

- a. Maintain low temperature for process control.
- b. Avoid surface condensation.

2.2 All applications of insulation shall be made in accordance with this specification. Contractor shall submit with his proposal, information on intended practices of insulation application, which are not covered in this specification, for approval of the Engineer-in-Charge. This information shall include all the details and sketches including those for the following :

- a. Removable insulation housings;
- b. Flashing details;
- c. Additional Insulation supports;
- d. Vessel head insulation supports;
- e. Expansion joints;
- f. Vessel insulation details;
- g. Exchanger removable housings;
- h. Machinery removable housings etc.

2.3 Protection of Materials During Storage

Insulation materials must be protected against any damage, from delivery to finish cladding. Decking and covering with tarpaulins alone are not considered sufficient protection from weather for any length of time and shall not be permitted. Insulation material slabs and sections shall be stored on a flat surface in a horizontal position. Insulation material shall never be stacked directly on the ground. The contractor shall provide covered storage for insulation materials as directed by the Engineer-in-Charge.

2.4 Protection of Partially Completed Jobs

All precautions shall be taken to ensure that each day's work is vapour sealed and cladded during erection and before being left over-night to prevent seepage of water into the materials and getting trapped. The system shall be protected by tarpaulins, water shed and other protective means.

2.5 Hydrostatic Test

Insulation shall be applied on vessels, heat exchangers, piping and other equipment only after successful completion of hydrostatic test. In case insulation work starts before completion of hydrostatic test, all welded and mechanical joints shall be left exposed for testing and subsequently insulated after successful completion of the hydrostatic test.

2.6 Co-ordination with Other Agencies

Contractor shall work in close co-ordination with the erection Contractor. Wherever temporary supports are provided the Contractor shall remove these and provide the necessary

insulating blocks (wood/PUF etc.) as per support standard or as specified in the bid package/tender.

2.7 Extent of Insulation

2.7.1 Items requiring Insulation

- Items requiring insulation are specified in the piping line schedule and equipment/vessel/heat exchanger data sheets.
- All attachments and projections such as vessel supports, structural steel attached to vessels, piping hanger supports, instrument lead lines, branch lines like vents, drains and instrument connections connected directly to cold insulated piping, vessels and equipment shall be cold insulated upto a distance of 4 times the adjoining insulation thickness.
- All flanged joints, manhole covers, etc. shall be cold insulated with removable box insulation. For insulation of manhole covers refer Drg. No. 09.

2.7.2 Items not requiring insulation

- Bonnet of valves above the packing glands.
- Nameplates, stampings and code inspection plates on vessels & equipment

3.0 INSULATION MATERIALS

3.1 General

All materials used for insulation, fixing sealing and protection shall be new and shall conform to the details given below and in clause 4.0. All insulating materials whether dry or wet shall be non-corrosive to the surfaces insulated.

3.2 Insulation material for insulating piping, vessels and equipment in Cold and Dual temperature (Cold/Hot) service shall be as given below :

Operating temperature range	Insulation material
-110°C to +120°C	Polyurethane foam (PUF/PIR)

Note: Detailed Job Specification shall be prepared for materials other than PUF & for the temperature beyond the limits as specified in clause 1.1.

3.3 Form of insulation shall be as follows :

Pipes upto 400 NB	Preformed pipe sections
Pipes upto 450 NB	Preformed pipe sections/Radial lags
Vessel Shells	Radial lags
Vessel heads	Preformed sections or slabs contoured to the profile of vessel heads.
Equipments	Radial lags or slabs as applicable to form, contour of the service to be insulated.

3.4 Dimensions of preformed sections for piping insulation shall be defined by the outside diameter and insulation thickness. Tolerances for preformed sections shall be as under:

Outside diameter	-0%, + 5%
Concentricity	$\pm 3\%$ O.D.
Bore	+ 2mm, -0 mm
Length, width and thickness of slabs	$\pm 2\text{mm}$

3.5 The material used shall not disintegrate, settle, change its form or composition in a detrimental way at the service conditions.

3.6 The insulating material shall be chemically inert, moisture free, rot and vermin proof.

3.7 Preformed half sections and slabs shall be provided having their longitudinal and circumferential faces flat and smooth so as to mate with the mating sections of the whole face area. Ends of the preformed half sections shall be flat and perpendicular to the centre line.

3.8 Polyurethane Foam

3.8.1 The insulation material shall be rigid preformed cellular urethane foam of self extinguishing type in accordance with ASTM C 591, Type II, Grade 2. The foam shall be formulated in such a way that it shall be of a self extinguishing quality which under no circumstances shall cause fire to spread.

3.8.2 Composition

The insulation material shall be produced by reacting poly Isocyanates with polyhydroxy compounds and expanded with a blowing agent. The finished foam in the form of slabs or half sections shall be of uniform closed cell structures, free from unreacted materials, shrinkage and distortion.

3.8.3 Density

The density of finished foam shall be within 35.0 kg/m^3 to 40 kg/m^3 and shall be determined in accordance with ASTM C-302.

3.8.4 Thermal Conductivity

Thermal conductivity of the Polyurethane foam slabs and sections shall not exceed $0.019 \text{ K Cal/hr. m}^\circ\text{c}$ ($0.16 \text{ BTU/ft}^2 \text{ hr}^\circ\text{F/in}$) at 10°C mean temperature after ageing. The thermal conductivity shall be tested by the method prescribed in ASTM C335.

3.8.5 Closed Cell Content

The closed cell content shall be at least 95% by volume.

4.0 ANCILLIARY MATERIALS

4.1 Wire-netting, Lacing & Binding Wire

Wire netting shall be galvanized 24 SWG x 20mm to secure insulation blocks. Lacing and stitching wires shall be 20 and 22 SWG galvanized iron wire respectively.

4.2 Bands

Bands shall be of Aluminum, of dimensions 20mm width x 24 SWG, unless specified otherwise.

4.3 Adhesives

The adhesive to be used for bonding insulation sections shall be Foster Fire Resistive Adhesive 81-33.

4.4 Vapour Seal

The vapour seal shall be Foster Fire Retardant Mastic 60-30.

4.5 Filler Material

PUF/PIR or Mineral Wool mixed with specified adhesive shall be packed rightly so as to fill all irregular voids and at contraction joints.

4.6 Joint Sealer

The joint sealer to be used for sealing insulation joints and at flashing of insulation shall be Foster Foam Seal Sealer 30-45.

4.7 Glass Cloth

The glass cloth to be used for vapour barrier reinforcement, shall be open weave 10 mesh Glass Cloth having glass fibre thickness of 5 mils.

4.8 Aluminium sheets for cladding of Vapour barrier on the insulation shall be as follows:

Application	Aluminium Sheet Gauge
a. Pipe Vessels and Equipment upto 500mm Nominal dia	26 SWG
b. Pipe Vessels and Equipment above 500mm Nominal dia	24 SWG
c. For Valves, flanges and other areas where mechanical damage is likely to occur	22 SWG

4.9 Anti-Corrosive Paint

One coat @ 65-75 μ DFT of primer, inorganic zinc silicate shall be applied on all carbon steel and alloy steel piping and equipment before application of cold insulation. Items made of stainless steel and other non-ferrous alloys shall not be painted but shall be wrapped with 0.1mm aluminium foil before application of cold insulation unless specified otherwise.

4.10 Bituminized Roofing Felt

Bituminized self finishing roofing felt shall conform to IS: 1322, type 3, grade 1.

5.0 APPLICATION

5.1 General

The following applies to all types of cold insulated equipment and piping:

5.1.1 Surface Preparation

The surfaces of tanks, vessels, piping and valves etc. on which cold insulation is to be applied shall be free of dust, loose paint or any other foreign matter. The surface irregularities shall be filled up with the approved filler. One coat of anticorrosive primer (as per clause 4.9) shall be applied over the carbon/Alloy Steel surfaces to be insulated and allowed to dry before application of insulation.

5.1.2 Insulation Thickness and Limit

Insulation thickness shall be in accordance with the equipment data sheets and piping line schedule. Insulation thickness on item covered in clause 2.7.1a & 2.7.1b shall be equivalent to that on adjoining piping and equipment.

5.1.3 Vapour Barrier for Polyurethane Insulation

A 3.0 mm (wet) thick coating of vapour seal mastic shall be applied to the surface of the insulation as soon as possible after erection, to reduce the time the insulation is exposed to the weather to a minimum. Whilst this coat is still wet, glass cloth shall be laid over the surface and embedded in the mastic. Care shall be taken to ensure that the glass cloth is laid smooth and free from wrinkles, and that no pockets of air are trapped beneath the surface. At junctions in the glass cloth, the overlap shall not be less than 75mm. A second 3mm thick coat of mastic shall be applied after approximately twelve hours. When dry this coating shall be a minimum of 1.50mm thick. Care must be taken, however to ensure that the individual coats are not greater than 3mm (especially in corners), otherwise some cracking of dried coat may result. The total dry film thickness of vapour seal shall not be less than 2.5mm with a tolerance of -0% to +50%. The mastic shall not be applied over wet insulation or until the adhesive is dry. During this drying time the insulation shall be protected from the weather by tarpaulin or similar materials approved by the Engineer-in-Charge.

Where joints have been left uninsulated, a complete vapour seal as specified above shall be applied to the exposed end of the insulation and flashed weather tight on to the metal.

5.1.4 Vapour barrier shall be protected by cladding with aluminium sheets. Joints in aluminium sheet shall be staggered and suitably sealed with an approved sealer. Aluminium cladding shall not be applied until the vapour barrier has completely dried and its solvents have dissipated. Self tapping screws shall not be used to secure aluminium cladding as they may puncture the vapour barrier.

5.1.5 Expansion / Contraction Joints

When specified on a pipe line or vessel drawing or where deemed necessary to allow movement and contraction of the pipe or vessel without producing random cracking of the insulation, contraction joints shall be provided in the insulation. At contraction joint location, provision shall be made in aluminium cladding to accommodate contraction of pipe or vessel.

The following steps shall be taken:

- a. Both longitudinal and circumferential joints in insulation shall be staggered.
- b. Contraction joints shall be provided at an interval depending on pipe or vessel material contraction/expansion co-efficient and temperature. Unless otherwise specified contraction joints shall be provided at an interval of 6.0m on straight run of pipes or vessels operating at temperatures (-)40°C & below.

- c. Contraction joints in horizontal vessel insulation shall be close to support points while on vertical pipes & vessels, the same shall be provided at support ring location and at an interval of 4.0m straight run.
- d. A contraction joint shall consist of 12mm gap in the Insulation, loosely packed with filler material, as applicable, described under clause 4.5 to a depth of 6mm less than the adjacent insulation thickness. 6mm gap thus left shall be filled up by approved non-setting compound (Foster Foam seal 30-45 sealer or equivalent) and finished smooth with the surface of insulation. Vapour barrier which shall cover the joint shall be applied only after the compound has dried. Expn/contraction joint details in insulation for 'horizontal & vertical pipes' & for 'expansion bellows' are given in Drg. Nos 10.1 to 10.4.

5.1.6 Stainless Steel Piping & Equipment

All pipes, vessels and equipment of stainless steel construction shall be wrapped with 0.1mm thick aluminium foil with an overlap of 50mm having barium chromate sealer interposed in the joint prior to application of insulation. Foil shall be secured in position by aluminium bands, taking every precaution to avoid formation of pin holes or cracking in the aluminium foil. Cladding shall be done after the insulation and vapour barrier exactly the same way as for other pipes and equipment.

- 5.1.7 For all pipes, vessels, equipments etc. lying in a corrosive environment where Sulphur Dioxide or other corrosive media are likely to be present, stainless steel bands/clips shall be used to secure aluminium cladding in position.

5.1.8 Field Welding

Field welding of clips or other insulation supports on any vessel or piping, subjected to the pressure of operating fluid shall not be permitted. However, field welding on non pressure parts, to install insulation supports etc. can be permitted with prior approval of the Engineer-in-Charge, but extreme care shall be taken so that welding does not result in decrease of metal thickness or excessive burning of metal.

5.2 Application- Vessels & Equipment

5.2.1 General

Individual vessel and tank drawings indicate the location of insulation supports or anchorage, wherever required, to facilitate application of insulation and securing of insulation shall be provided by the contractor at his own cost. All surfaces shall be prepared as described in Clause 5.1.1 before application of insulation.

5.2.2 Single Layer Insulation

Insulation radial lags/preformed sections of handy sizes shall be installed on to the surfaces of vessels adhering to each other with applicable joint sealer and secured in position by G.I. wire netting and aluminium bands at an interval of 225mm. There shall be no through joints and the insulation shall not be bonded to the vessel.

5.2.3 Multilayer Insulation

The inner layer of insulation shall be bonded to the vessel with the applicable adhesive. Subsequent layers of insulation shall be bonded to the preceding layer, with the applicable adhesive. The joint sealer shall be applied to the ends and edges of all sections, including those in the inner most layer to seal all joints. Care shall be taken to ensure that the adhesive

is evenly spread over the entire surface of the application and the insulation is closely butted to each other both longitudinally and circumferentially.

All the layers except the final shall be secured in position by metallic bands at an interval of 225 mm while the final layer shall be first secured with G.I. wire net and then with metallic bands at an interval of 225mm. Bands shall be staggered on successive layers. There shall be no through joints in the insulation.

5.2.4 Filling

All the cracks and voids in the main insulation shall be filled up with applicable filler material, as described under clause 4.5.

5.3 Vertical Vessels

5.3.1 Shell (Cylindrical)

Slabs in handy sizes as given below shall be applied resting onto the supports with joints tightly butted, staggered & adhering to each other with applicable adhesive and secured in position by circumferential metallic bands at a pitch of 225mm.

For vessels upto 2.5m O.D. - Radial lags of suitable width

For vessels over 2.5m O.D. - Radial lags. However the procedure given below can be used as an alternative.

Flat insulation slabs of width not more than 300mm shall be cut longitudinally to have notch (es) of suitable size spaced at suitable spacing, so as to form a radial segment suitable for the profile of the vessel shell. However extreme care shall be taken to ensure that no air pockets are formed in the finished insulation. All insulation joints shall be sealed with applicable joint sealer.

Where more than one layer is used, each layer shall be banded separately as given in Clause 5.2.3. Method of application shall be as given in Drg. No. 01. When mineral wool insulation is used, notches shall not be cut as the insulation itself is semi rigid and can be pressed to form contour of the shell.

5.3.2 Top Heads

Shaped insulation sections shall be installed on top head, banded and butted tightly to each other. Insulation shall be held in position by making use of galvanized iron floating ring (25mm x 0.6mm) placed over the insulation and positioned in the centre of the head so as not to touch the nozzle at the vortex. The insulation shall be held in position by use of radial metallic bands, one end of which shall be fastened to floating ring and the other end shall be anchored to the band(s) placed around the cylindrical section close to the head. Radial bands shall be spaced on 300mm centres measured around the circumference of the vessel.

The final layer of insulation shall be held in position also by metallic wire net laced at the nozzle location by 2-3 loops of 10 SWG galvanized wire and to the wire net over insulation on the shell at the cylindrical section close to the head.

When there is no nozzle at the top at the Vortex, the insulation shall be held in position by wire netting and metallic bands stretched over the head and anchored on the cylindrical section close to the head by circumferential metallic band(s) on the shell and near the head.

5.3.3 Bottom Heads

In all the skirt supported vessels, insulation supports are provided inside the skirt as indicated in the equipment drawings, Drg No. 15.

Floating ring and wire loops around the nozzle and bands shall be used to support downward facing of insulation. Such a floating ring shall be positioned centrally around the nozzle but over the insulation by radial bands anchored to the lagging support angle ring fixed inside the skirt at a pitch of 300mm measured over the support angle ring.

If nozzle is not existing, metallic bands shall be stretched across the bottom head and anchored with lagging support angle ring inside the skirt. All the wire ends of wire netting shall be cut short and turned into the insulation.

5.4 Horizontal Vessels

The insulation radial lags of handy sizes shall be installed in close contact with the faces to be insulated and held in position by G.I. wire netting and metallic bands at a pitch of 225mm. Where more than one layer is required, each layer shall be banded separately. The bands for successive layers shall not coincide with each other, wire netting on the final layer shall be applied and ends shall be laced together by lacing wire before putting the metallic bands as per Clause 5.2.3.

Insulation sections on the vessel heads shall be secured in position by wire netting and metallic bands stretched across the heads and anchored to circumferential metallic band(s) on the shell near the heads. Anchoring of bands measured on the circumference of shell shall be of a pitch of 225mm max. Method of application of insulation shall be as given in Drg No. 02.

5.5 Tank Insulation

Material and method of application for tanks shall be the same as specified for vessels. Flat aluminium sheets for weather proofing shall be used exactly in the same manner as specified for other vessels.

5.6 Spherical Vessels

Insulation of spherical vessels shall be performed as shown in Drg No. 03. Before commencing the application of insulation, the contractor shall ensure that exterior surfaces have been prepared in accordance with clause 5.1.1. Shaped insulation to fit curvature of sphere shall be bonded to the vessel with applicable adhesive. All insulation joints shall be sealed with applicable joint sealer. The inner layer of insulation shall be held in position by 20mm x 20 SWG aluminium bands of 300mm max. centres of the equator. These bands are tied up with the rings provided as per EIL std 7-13-0034. The bands being staggered on successive layers and the clips of the bands being recessed into the insulation. Over the outer layer galvanized wire netting shall be spread over and laced together.

5.7 Vapour Barrier

Vapour barrier shall be applied on all the vessels described above as per the procedure outlined in Clause 5.1.3.

5.8 Metal Sheet Finishing

5.8.1 Horizontal Vessels

The insulation shall be covered with aluminium sheeting with all the longitudinal and circumferential joints having an overlap of minimum 50mm. All longitudinal and circumferential joints shall be sealed with suitable approved bituminized mastic sealer. Aluminium sheeting shall be secured in position by metallic bands on the shell at a max. pitch of 425mm. All the longitudinal joints with overlap of 50mm in the aluminium sheet shall be kept below the horizontal plane passing through the axis of the vessel to prevent water or other spillage from entering into the insulation.

Jacketing for dished heads shall be fabricated from radial segments with the radial overlap of minimum 50mm. The sheeting shall be secured in position by radial tensioned metallic bands stretched over the heads. One end of each band is anchored to the circumferential band(s) on the shell while the other is fastened (pop riveted) to 6mm dia. Floating rod ring which can be replaced by 6mm thick strip (G.I.) rolled in the form of a ring. Radial metallic bands, measured over the circumference of shell, shall be at a pitch of 300mm. All the sheet metal joints shall be properly sealed with approved sealing mastic.

5.8.2 Vertical Vessels

The aluminium sheeting shall be adequately rolled and installed over the insulation such that all the longitudinal joints are staggered. All the longitudinal and circumferential joints shall have an overlap of 50mm minimum and suitably sealed with approved mastic sealer. Aluminium sheeting shall be secured in position by tensioned metallic bands installed circumferentially at a max. pitch of 425mm.

a. Top Heads

Insulation shall be covered with flat aluminium jacket fabricated in segmental form with lapped joints properly sealed with approved mastic sealer. Over-lapping of sheet metal joints shall not be less than 50mm. Aluminium jacket shall be secured in position by radial tensioned metallic bands anchored to the circumferential band(s) of vessel on one side and fastened to 6mm dia. floating rod ring, centralized at the vortex of head on the other side. 6mm thick metallic (G.I.) strip rolled into a ring can be a substitute for 6mm dia. Rod. Pitch of radial bands measured over the circumferential bands of shell shall be max. 300mm.

b. Bottom Heads

Aluminium sheeting shall be installed exactly in the same manner as indicated for top heads.

5.8.3 Spherical Vessels

Cladding of each hemisphere of spherical vessel shall be done with aluminium sheets placed horizontally and a thick circumferential tensioned band (6mm thick) shall be used at the equator to hold the radial metallic bands.

5.8.4 Others

Openings in metal jackets for nozzles, manways, brackets etc. shall be cut as close as possible for a snug fit.

5.9 Flashing

All openings through insulation finish shall be flashed weather tight particularly where connections are not insulated. Flashing shall be carried out as per details given in Drg Nos 14.1 & 14.2. Skirt supported vessels shall have the skirt insulated inside and outside for at least 600mm below the tangent line or such that temp. of adjacent non insulated surfaces of the skirt shall not be below dew point. Proper flashing and sealing shall be done on skirt where insulation and subsequent metal finish terminates as given in Drg No. 15.

5.10 Exchanger Insulation

Exchanger shells except for channels and channel covers shall be insulated and weather proofed as specified for vessels.

Exchanger channels and channel covers including flange bolting shall be insulated with removable aluminium covers lined with insulation slabs of required thickness.

5.11 Machinery

In general, removable aluminium boxes lined with slab insulation of required thickness shall be used for insulation of machinery after giving a coat of anticorrosive paint. The contractor shall submit details of individual pieces of equipment depending on the nature of items to be insulated to the Engineer-in Charge of site for approval.

5.12 Application – Piping

5.12.1 General

Insulation shall be applied on after ensuring that piping to be insulated is properly installed, supported and tested. Refer Drg No. 04 for application of insulation.

5.12.2 Horizontal Piping

- a. Piping surface shall be cleaned of loose rust, mill scale, grease, dust or any other foreign contaminants. Surface preparation shall be done in accordance with clause 5.1.1.
- b. The insulation shall be applied to pipes in half round sections in reasonably handy sizes.

Where insulation thickness required is greater than 50mm or that the metal temp. is below (-) 40°C, multilayer construction shall be followed with all the joints staggered in successive layers.

- c. The inner layer of insulation shall be bonded to the piping with applicable adhesive. Subsequent layers of insulation shall be bonded to the preceding layers with the above adhesive. Joint sealer shall be applied to the ends and edges of all sections for sealing all longitudinal and circumferential joints. Adhesive shall be applied evenly and the half sections shall be closely butted to each other both longitudinally and circumferentially.
- d. All the insulation layers except the final shall be secured in position by metallic bands at an interval of 225mm, while the final layer shall first be secured with G.I. wire netting and then with metallic bands at an interval of 225mm. Bands shall be staggered on successive layers.
- e. Insulation of piping shall be stopped short of flanges to allow for withdrawal of bolts. For fittings, the insulation shall be completed by applying cut segments of the same insulation sections used for pipes.

- f. Any cracks of irregularities in the external surface of insulation sections shall be filled up by applicable filler material, as described under clause 4.5.
- g. For long run of pipes, the ends of insulation sections shall be sealed off at 12m intervals and vapour barrier carried down upto the metal surface.
- h. Contraction joints shall be provided at an interval of 6.0m unless otherwise specified as per Clause 5.1.5.

5.12.3 Vapour Barrier

Vapour barrier shall be applied over the insulation as outlined in Clause 5.1.3.

5.12.4 Metal Sheet Finishing

Vapour barrier (after it has dried) shall be protected by cladding it with specified Aluminium sheeting. All joints between adjacent aluminium sheets shall be staggered and grooved with a minimum overlap of 25mm, and suitably sealed with approved sealer. The longitudinal joints shall have single grooves while the circumferential joints shall have two grooves. Aluminium or G.I. bands/clips at an interval of 425mm shall be used to secure the aluminium cladding in position. Self tapping screws shall not be used.

For pipes, vessels and equipments lying in a corrosive environment where Sulphur Dioxide is likely to be present, stainless steel bands/clips spaced at intervals of 425mm shall be used to secure the aluminium cladding in position.

5.12.5 Vertical Piping

Insulation, vapour barrier and metal sheet finishing shall be performed as specified for horizontal piping. Contraction joints shall be provided in accordance with clause 5.1.5.

Insulation support/spacer rings shall be provided at an interval of 4.0m (if other insulation supports are not already existing on the pipe) as shown in Drg No. 05.

5.12.6 Pipe Supports & Hangers

In all the supporting arrangements of both horizontal and vertical piping, dry hard wood pipe support bearing blocks coated with fire retardant paint/mastic or PUF, as applicable, shall be used. Metal cradles, metal pipe supports and hangers shall be attached to outside of the pipe support bearing blocks and not directly to bore pipe. Provision shall be made to prevent seepage of water into the insulation from pipe hangers.

5.12.7 Flanges & Valves

Removable covers shall be provided over all flanges and valves. Insulation shall be performed as per the details given in Drg 7 & 8. Loose fill mineral wool backed up by slab insulation of thickness equal to that an adjacent pipe shall be applied. Aluminium covers over the valves and flanges shall be fitted with quick release clips. This application shall be proposed for each case by the insulation contractor and approved by the Engineer-in-Charge.

5.12.8 Refrigerant Traced Lines

- a. The lines to be refrigerant traced shall be given in the line schedule and also shall be given in layout drawings and isometrics.

- b. When lines are traced with one or more tracers, insulation shall be of sufficient size to house the assembly without distortion or damage to the insulation.
- c. The refrigerant traced assemblies shall be first wrapped with specified wire netting, thus ensuring tracer pipe wearing tightly against the line refrigerant – traced.
- d. Application of insulation shall be exactly the same as for piping described earlier and as given in Drg. No. 13.
- e. Application of vapour barrier and cladding with aluminium sheet shall also be same as for piping described earlier.

6.0 APPLICATION OF INSULATION ON PIPING, VESSELS & EQUIPMENT IN DUAL TEMPERATURE SERVICE (HOT/COLD)

PUF/PIR shall be insulation material for dual temperature service for the temperature range as specified in clause 3.2. Application of the same shall be in accordance with the procedure laid down in clause 5.0, for piping, vessels and equipment, as applicable. Other forms of insulation materials may be used if specified in the 'JOB SPECIFICATIONS'.

7.0 COLD INSULATION OF PIPING LOCATED AT OR BELOW GROUND LEVEL AND WHERE THERE IS A LIKELYHOOD OF FOOT TRAFFIC

- 7.1 Material of insulation shall be preformed sections of Polyurethane, as indicated in clause 3.3.
- 7.2 For Polyurethane insulation material, application shall be carried out in accordance with the procedure specified in clause 5.0, for piping, vessels and equipment, as applicable, except that instead of providing aluminium cladding over the final layer of vapour barrier, the procedure laid down in clause 7.3 shall be adopted.
- 7.3 Bituminized self finishing roofing felt shall be wrapped over the final layer of vapour barrier after it has fully dried, with an overlap of minimum 50mm both on longitudinal and circumferential joints.
 - 7.3.1 The roofing felt shall be secured with the specified galvanized iron wire netting, laced with 20 SWG galvanized iron wire.
 - 7.3.2 3mm thick Bitumen Emulsion mastic shall be applied for water and weather proofing.
 - 7.3.3 When bitumen emulsion has completely dried, the surfaces shall be painted with two coats of bitumen based aluminium paint.

8.0 SAFETY

The insulation contractor shall provide adequate protective appliances like hand gloves, masks, glasses etc. to the workmen carrying out the insulation work, to protect them from inhaling and touching insulation dust and fibres.

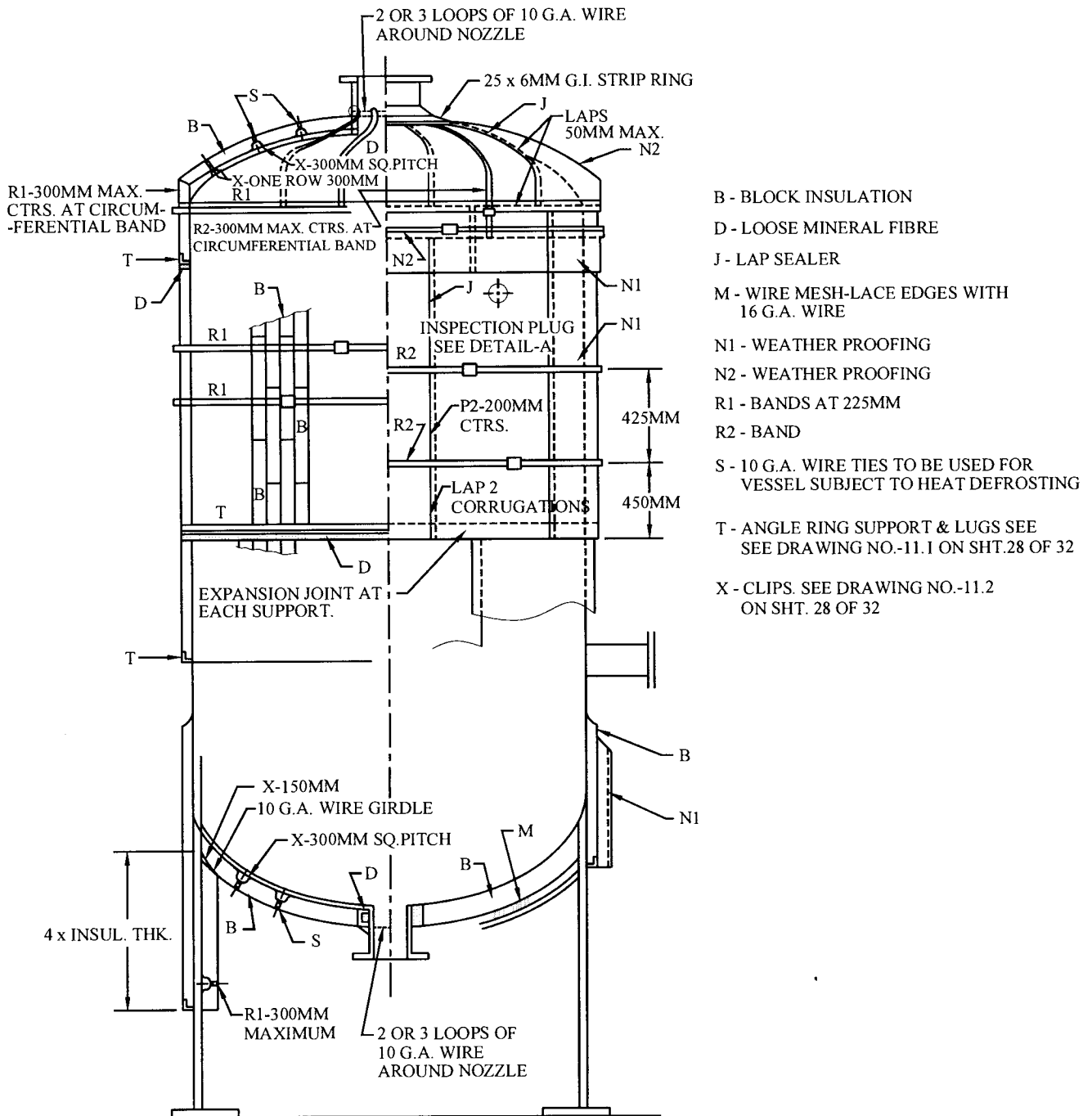
9.0 GUARANTEE

- 9.1 The insulation contractor shall submit along with the tender, authentic test certificates confirming that the insulation materials offered conform to the requirements of this specification and the Standards mentioned therein. Any deviations shall be clearly stated.
- 9.2 The insulation contractor shall guarantee the following :

- 9.2.1 The insulation and ancillary materials are new and unused and conform to the Standards mentioned in the Specification.
- 9.2.2 The operating thermal conductivity shall be as specified.
- 9.2.3 The workmanship in execution of the insulation works shall be in accordance with sound engineering practice.

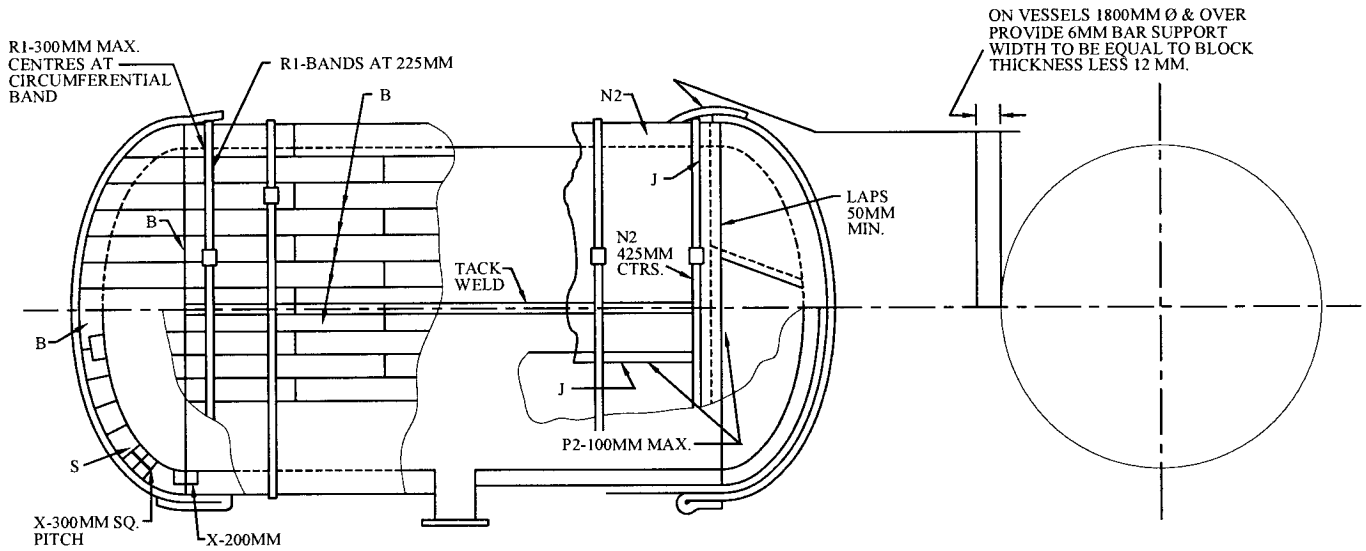
10.0 ATTACHMENT DRAWINGS

S.No.	Description	Drawing
1	Vertical Vessels- Cold insulation with Aluminium cladding on shell, top and bottom heads	DRAWING. No. 01
2	Horizontal Vessels- Cold insulation with Aluminium cladding	DRAWING. No. 02
3	Cold insulation for Spherical Vessels	DRAWING. No. 03
4.	Typical Cold insulation for Horizontal Pipes	DRAWING. No. 04
5.	Insulation Supports for Vertical Pipes	DRAWING. No. 05
6.	Method of Insulating feet of Vessels	DRAWING. No. 06
7.	Typical Cold Insulation for Flanged Joints	DRAWING. No. 07
8.	Typical Cold Insulation for Valves	DRAWING. No. 08
9.	Cold Insulation for Manholes	DRAWING. No. 09
10.	Multilayer Insulation Contraction Joint- Horizontal Vessels & Piping	DRAWING. No. 10.1
11.	Single layer Insulation Contraction Joint- Horizontal Vessels & Piping	DRAWING. No. 10.2
12.	Contraction Joint- Mechanical Expansion	DRAWING. No. 10.3
13.	Contraction Joint- Vertical Vessels & Piping	DRAWING. No. 10.4
14.	Supports for Block Insulation	DRAWING. No. 11.1
15.	Clips on Heads and inside of Skirt for Block Insulation	DRAWING. No. 11.2
16.	Details of Spacer Ring	DRAWING. No. 12
17.	Refrigerant Tracing Insulation	DRAWING. No. 13
18.	Method of Lagging Flanged Joints of Vessels	DRAWING. No. 14.1 & 14.2
19.	Method of Insulating Vessel Skirt (Alternative for Half or Full Insulation of Skirt)	DRAWING. No. 15



**VERTICAL VESSELS- COLD INSULATION WITH ALUMINIUM
CLADDING ON SHELL TOP & BOTTOM HEADS**

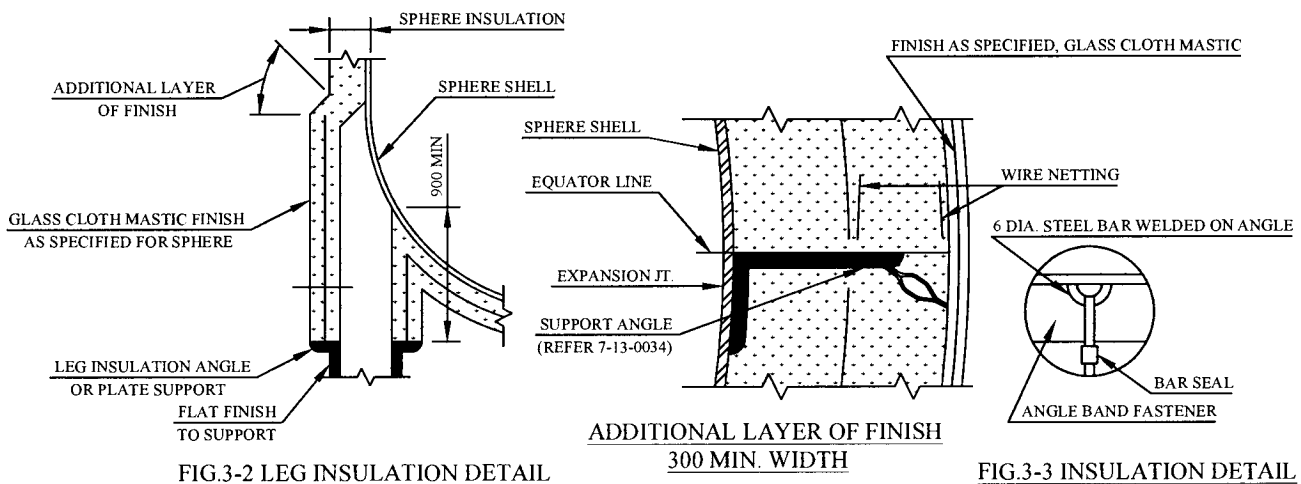
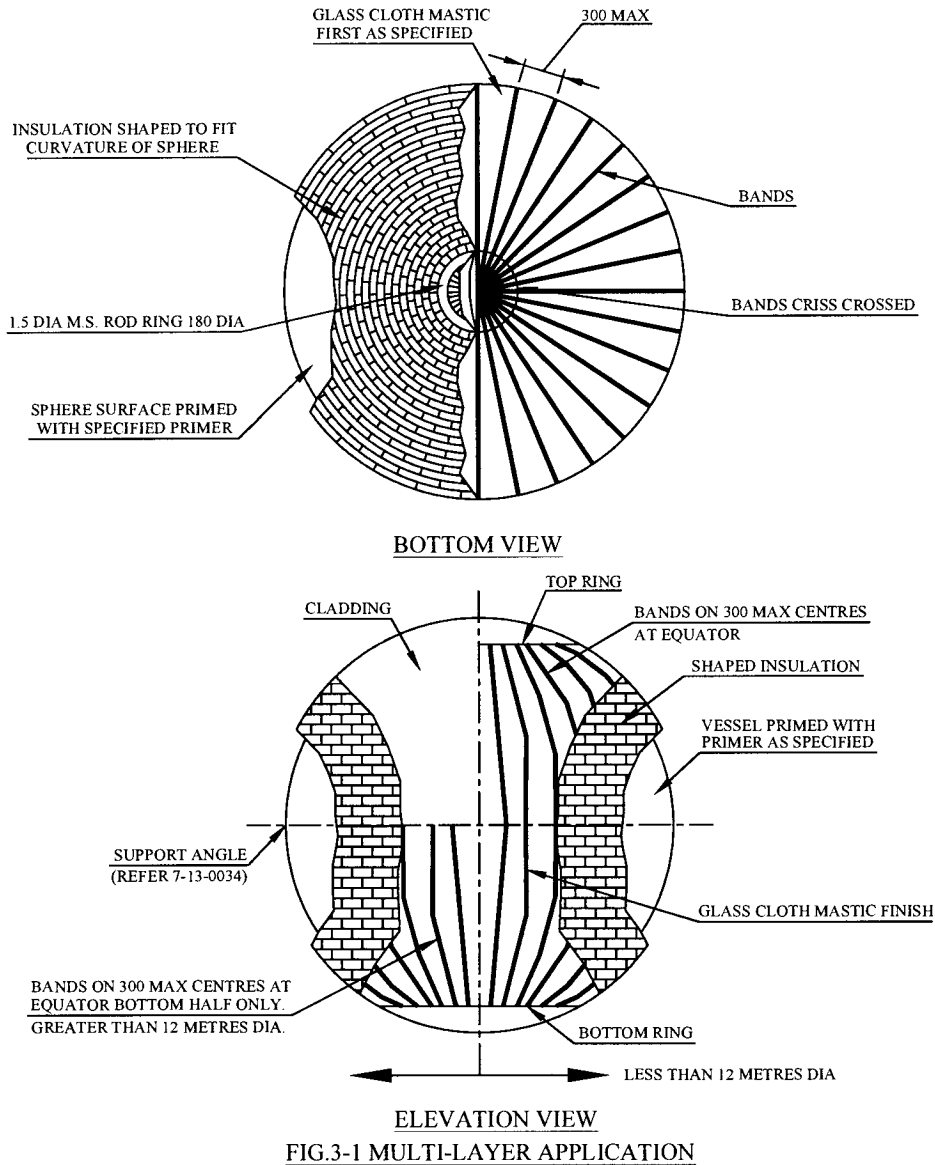
DRAWING NO. - 01



FOR S, B, N1, N2, R1, R2 & J REFER SHT. 17 OF 32

HORIZONTAL VESSELS - COLD INSULATION WITH ALUMINIUM CLADDING

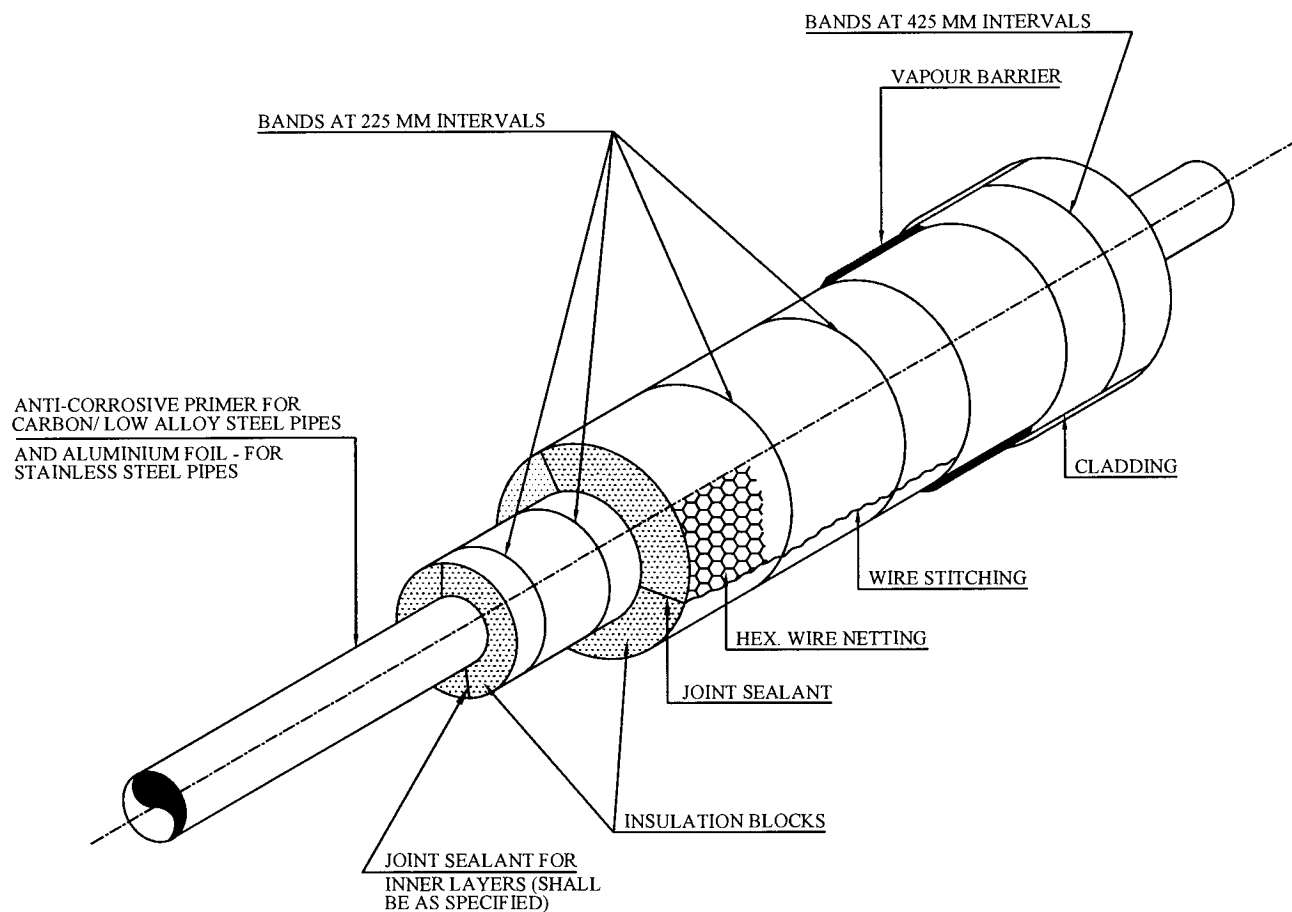
DRAWING NO.-02



NOTE: FOR DETAILS OF INSULATION SUPPORTS REFER STD. NO: 7-13-0034

COLD INSULATION FOR SPHERICAL VESSELS

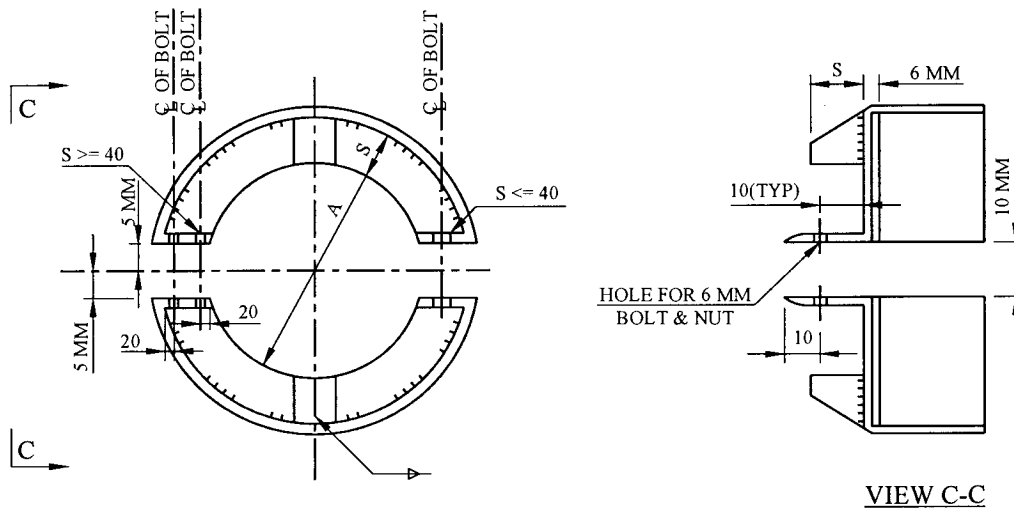
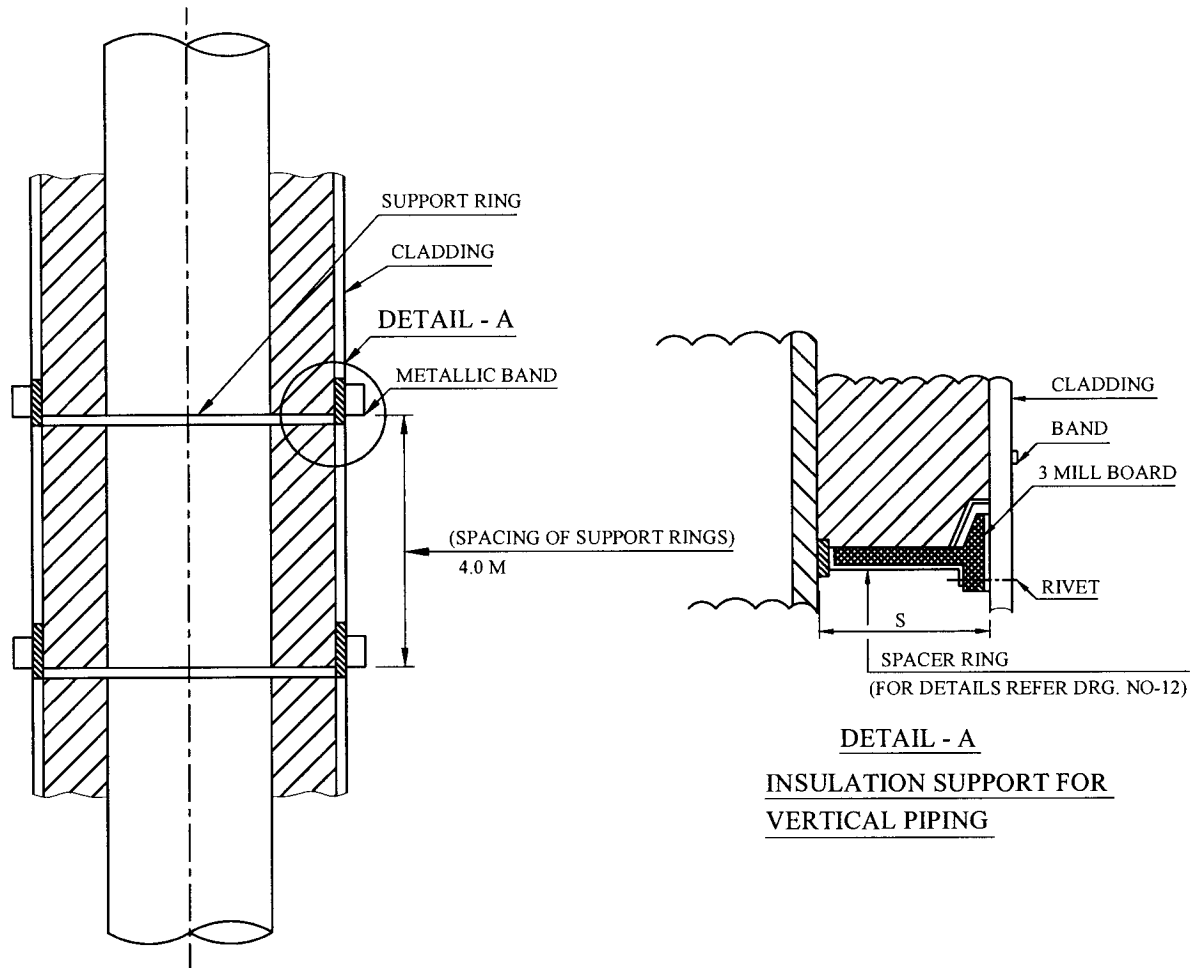
DRAWING NO.-03



Multilayer Insulation with Preformed Blocks

TYPICAL COLD INSULATION ON HORIZONTAL PIPES

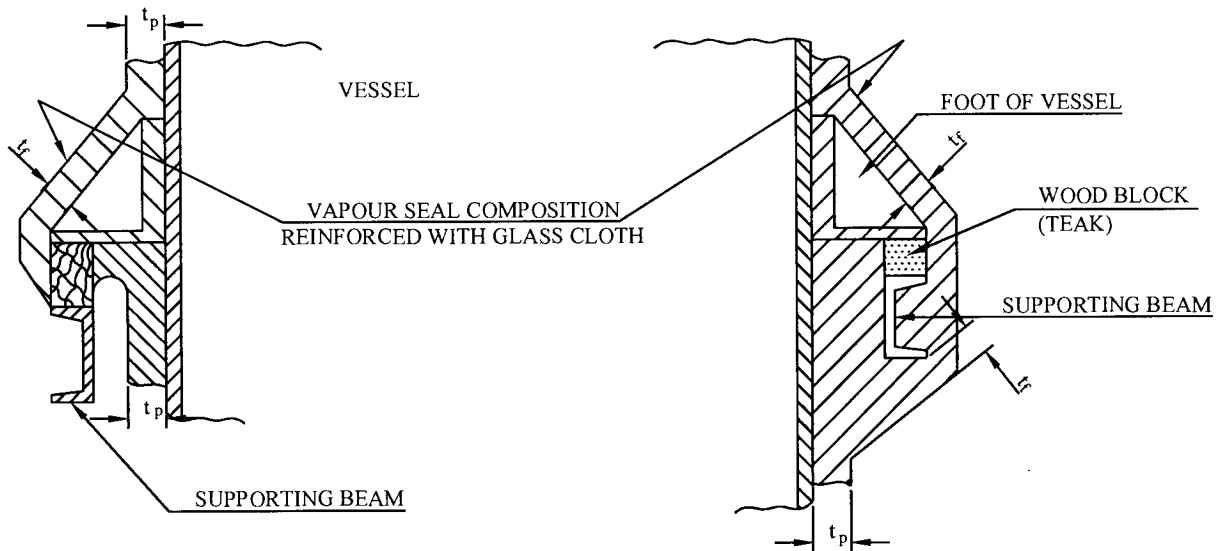
DRAWING NO.-04



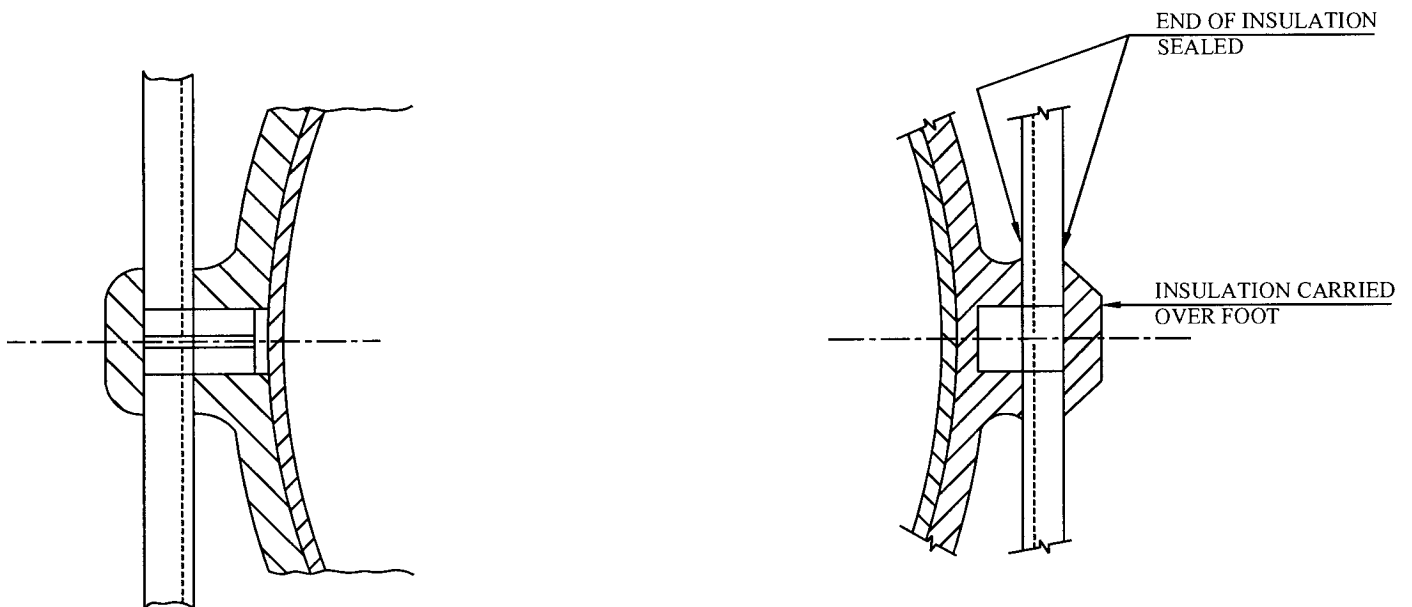
LEGEND:

- A DIMENSIONS TO MATCH O.D. OF PIPE OR O.D. OF VESSEL
- S INSULATION THICKNESS

SUPPORT RING FOR VERTICAL INSULATED PIPING
DRAWING NO.-05



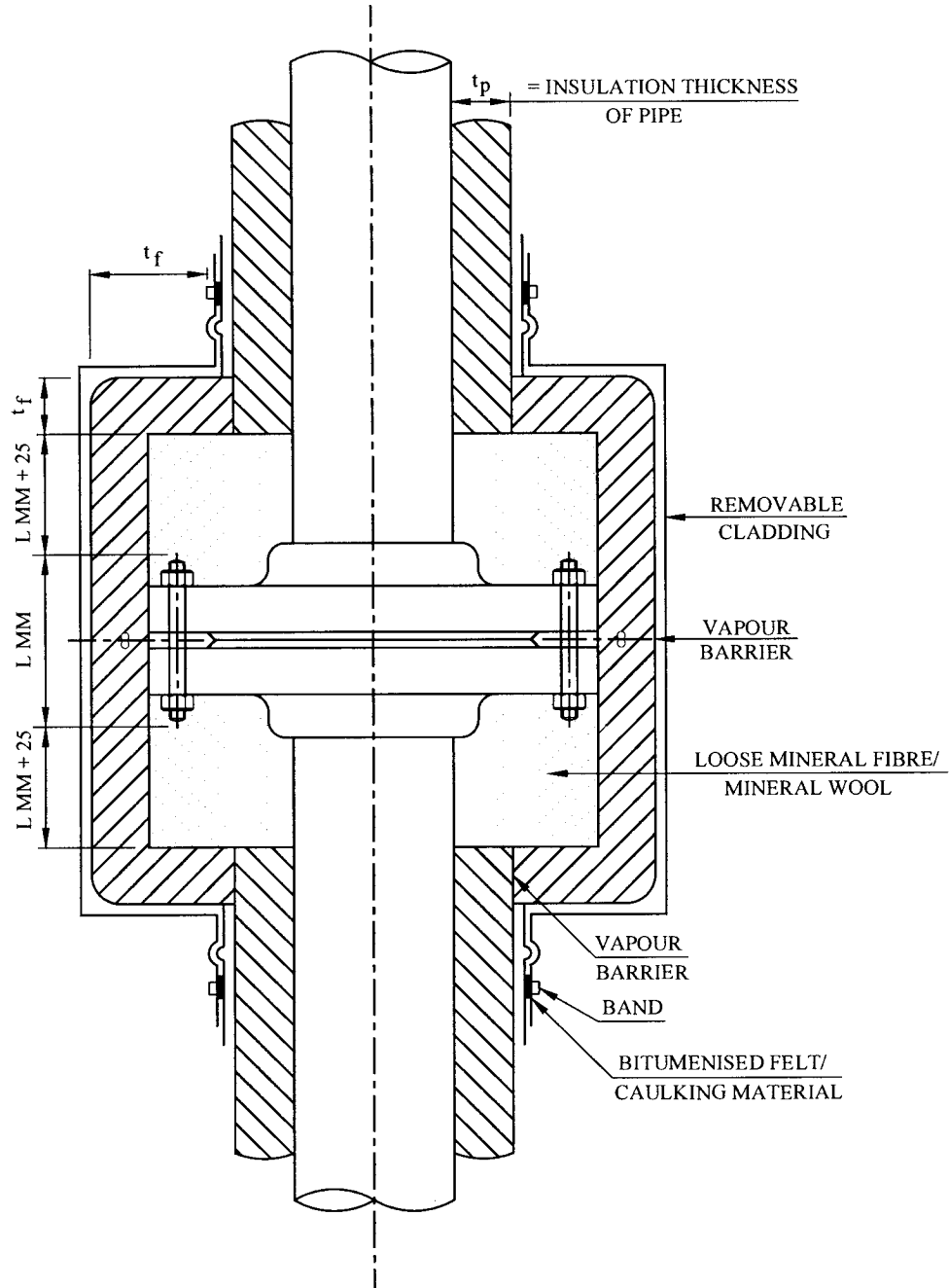
NOTE : ALL CORNERS MUST BE ROUNDED. MINIMUM RADIUS 25 MM.



t_p = THICKNESS OF VESSEL INSULATION
 $t_f = t_p$ $t_f = 100$ MM WHERE t_p IS BETWEEN 100 MM & 125 MM.

METHOD OF INSULATING FEET OF VESSELS

DRAWING NO.-06



t_p = THICKNESS OF LAGGING PIPE

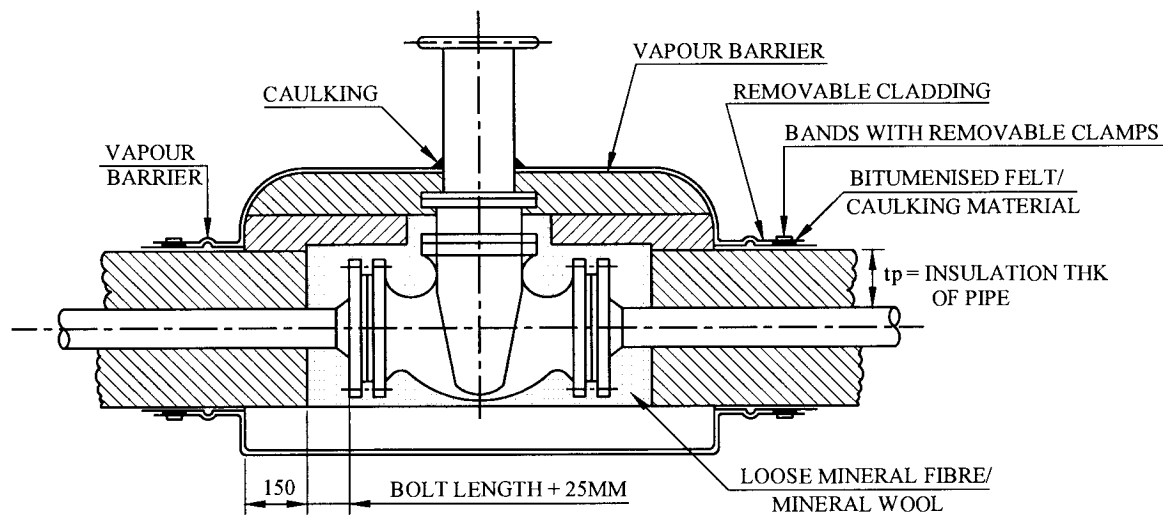
t_f = THICKNESS OF LAGGING FLANGE

$t_f = 100 \text{ MM}$ WHERE $t_p > 100 \text{ MM}$

$t_f = t_p$ WHERE $t_p < 100 \text{ MM}$

TYPICAL COLD INSULATION FOR FLANGED JOINT

DRAWING NO.-07

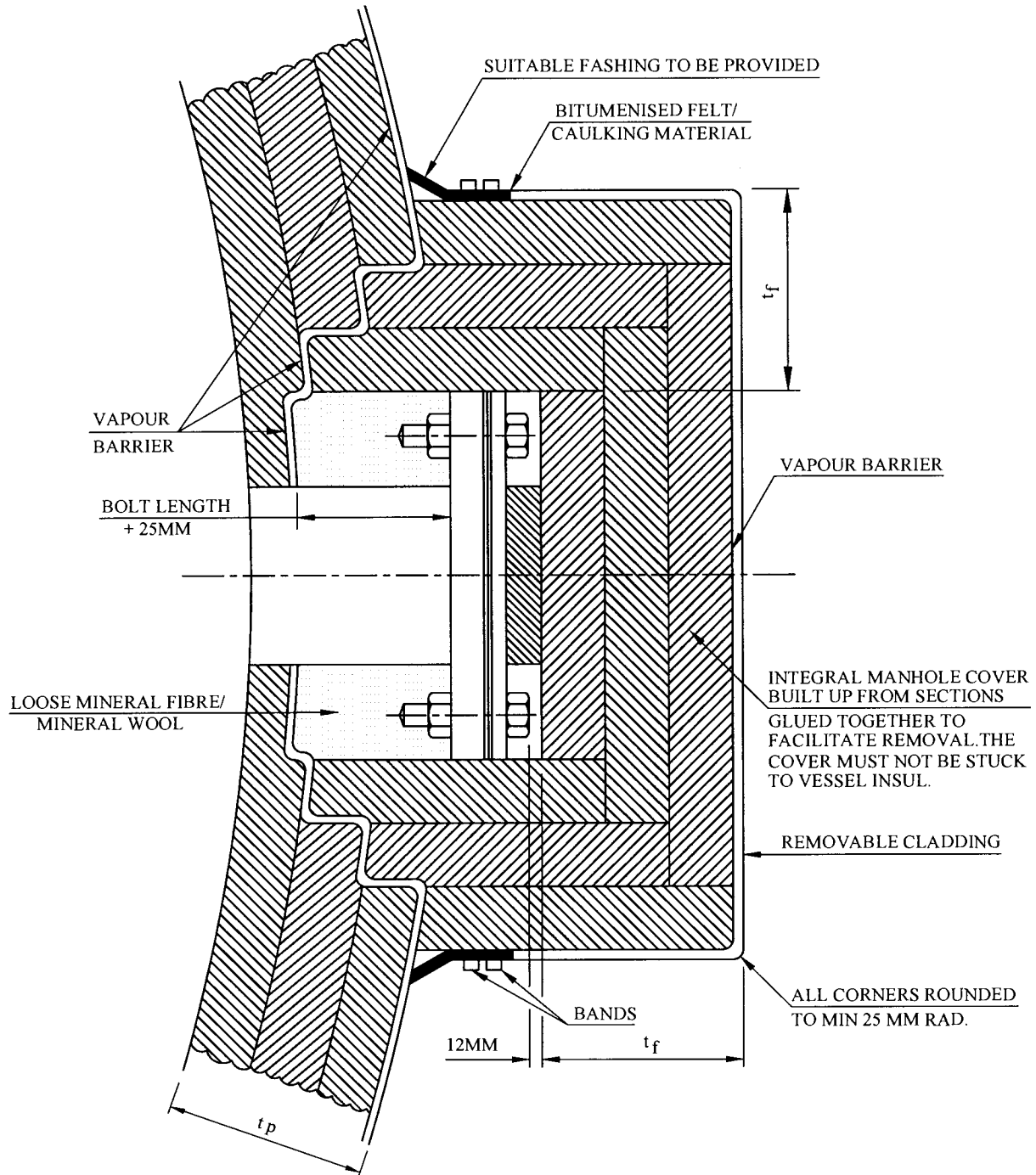


NOTES:

1. SUITABLE FLASHING TO BE PROVIDED TO RESULT IN EFFECTIVE VAPOUR BARRIER
2. THE INSULATION OF VALVE SHALL BE OF SUCH DESIGN THAT IT CAN BE REMOVED WITHOUT DISTURBING THE ADJACENT PIPE INSULATION.

TYPICAL COLD INSULATION FOR VALVES

DRAWING NO.-08



t_p = THICKNESS OF LAGGING IN VESSELS

t_f = THICKNESS OF LAGGING IN FLANGES

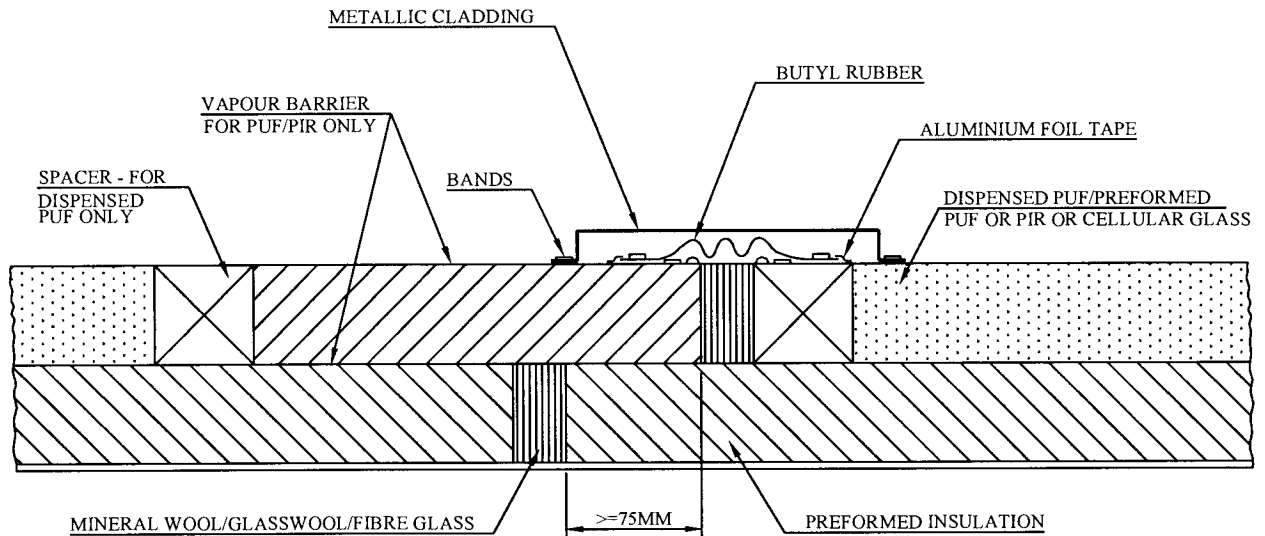
t_f = $t_p + 25$ MM WHERE $t_p > 125$ MM

t_f = 100 MM WHERE t_p IS BETWEEN 100 MM & 125 MM

t_f = t_p WHERE $t_p < 100$ MM

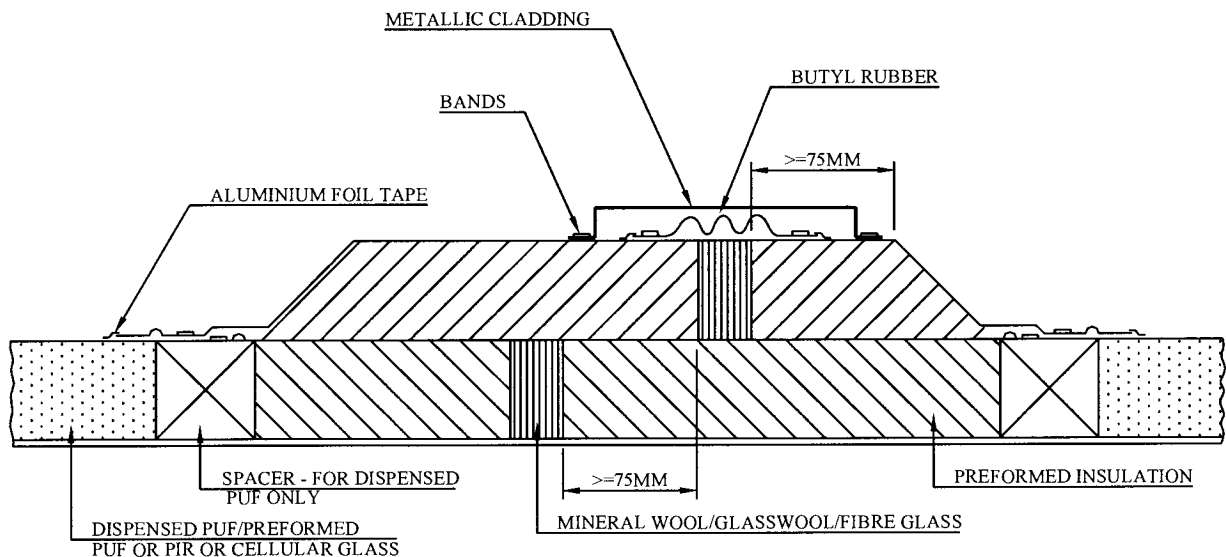
COLD INSULATION FOR MANHOLES

DRAWING NO.-09



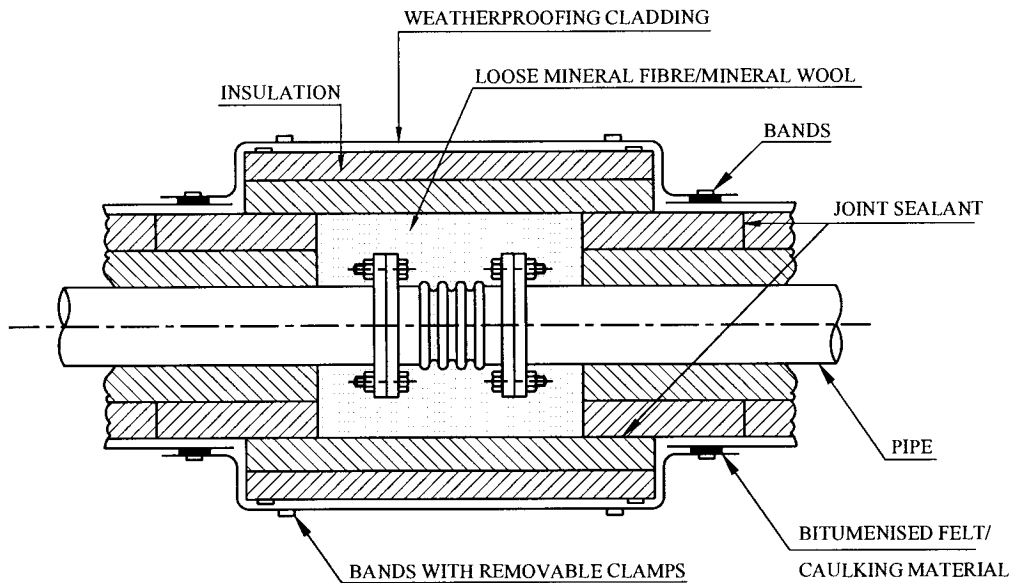
MULTILAYER INSULATION
CONTRACTION JOINT – HORIZONTAL VESSELS & PIPING

DRAWING NO.-10.1



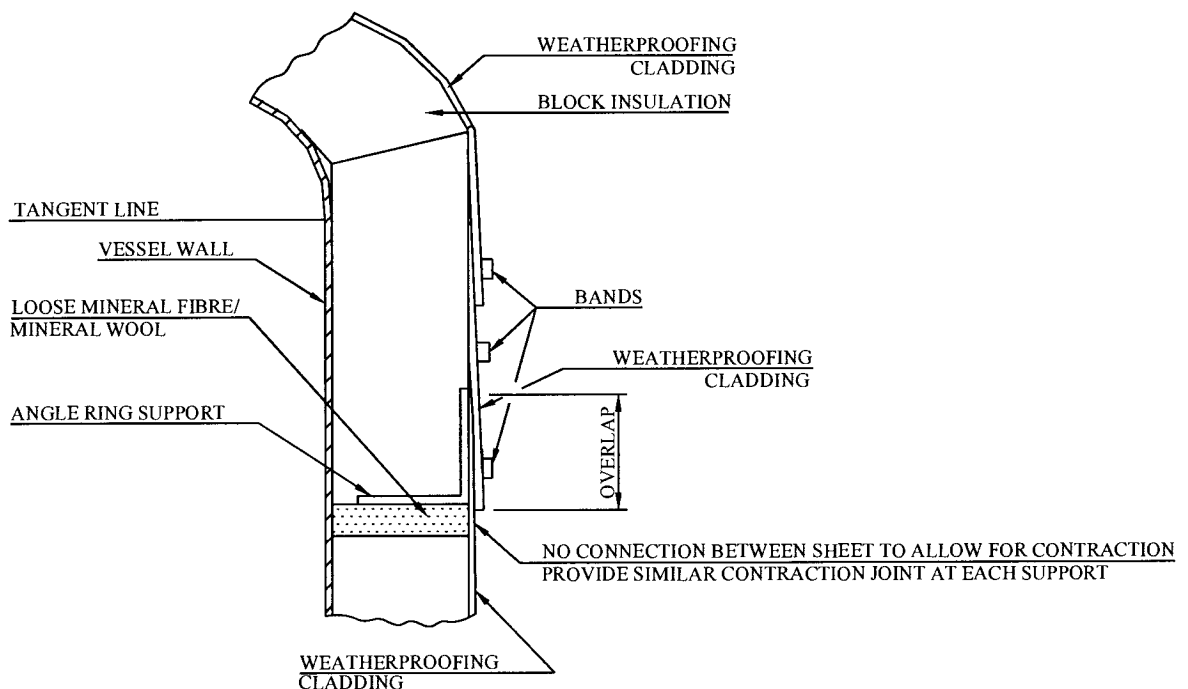
SINGLE LAYER INSULATION
CONTRACTION JOINT – HORIZONTAL VESSELS & PIPING

DRAWING NO.-10.2



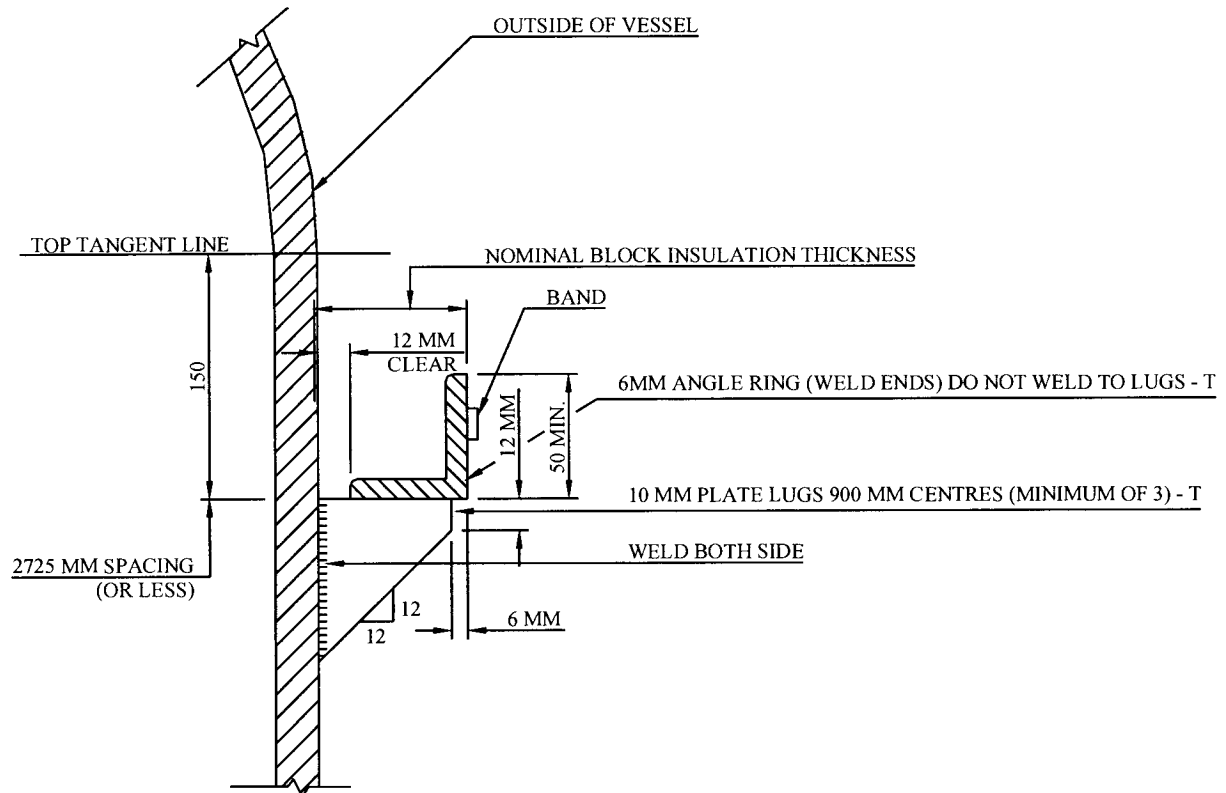
CONTRACTION JOINT – MECHANICAL EXPANSION

DRAWING NO.-10.3

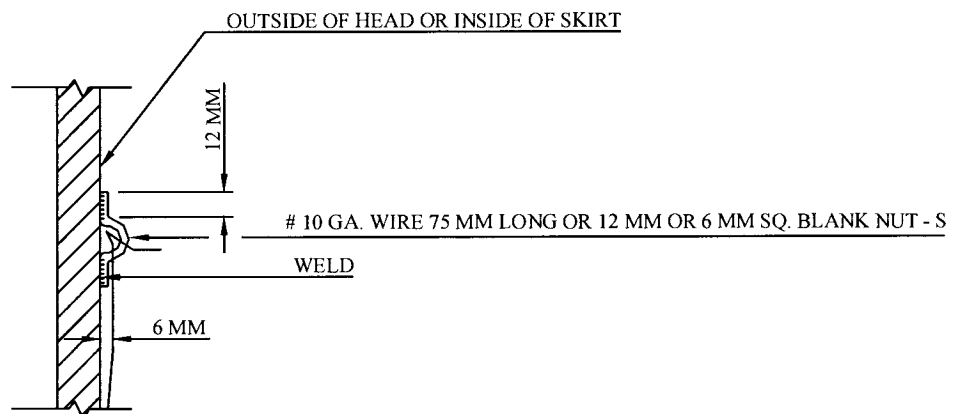


CONTRACTION JOINT – VERTICAL VESSELS & PIPING

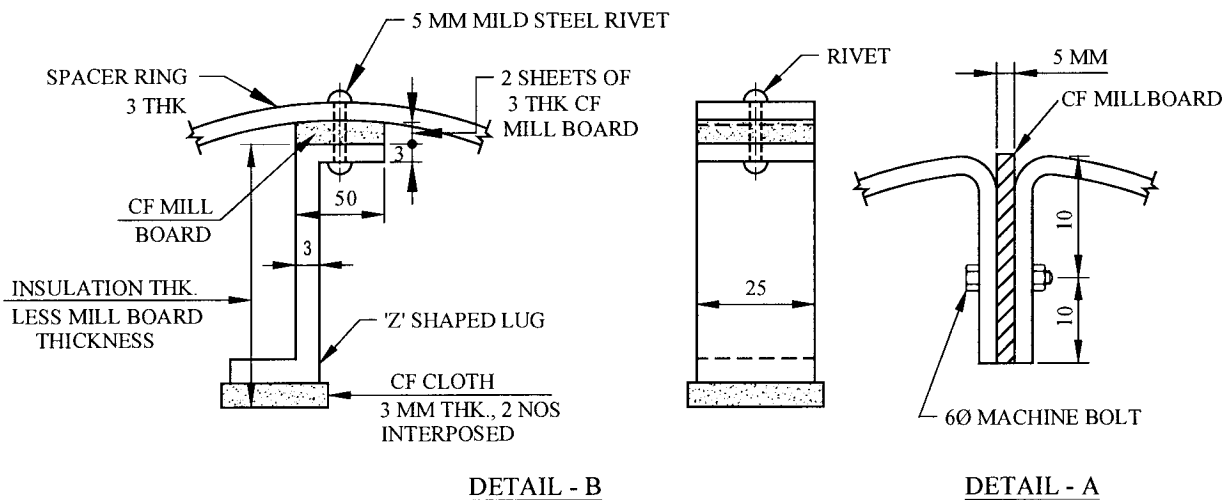
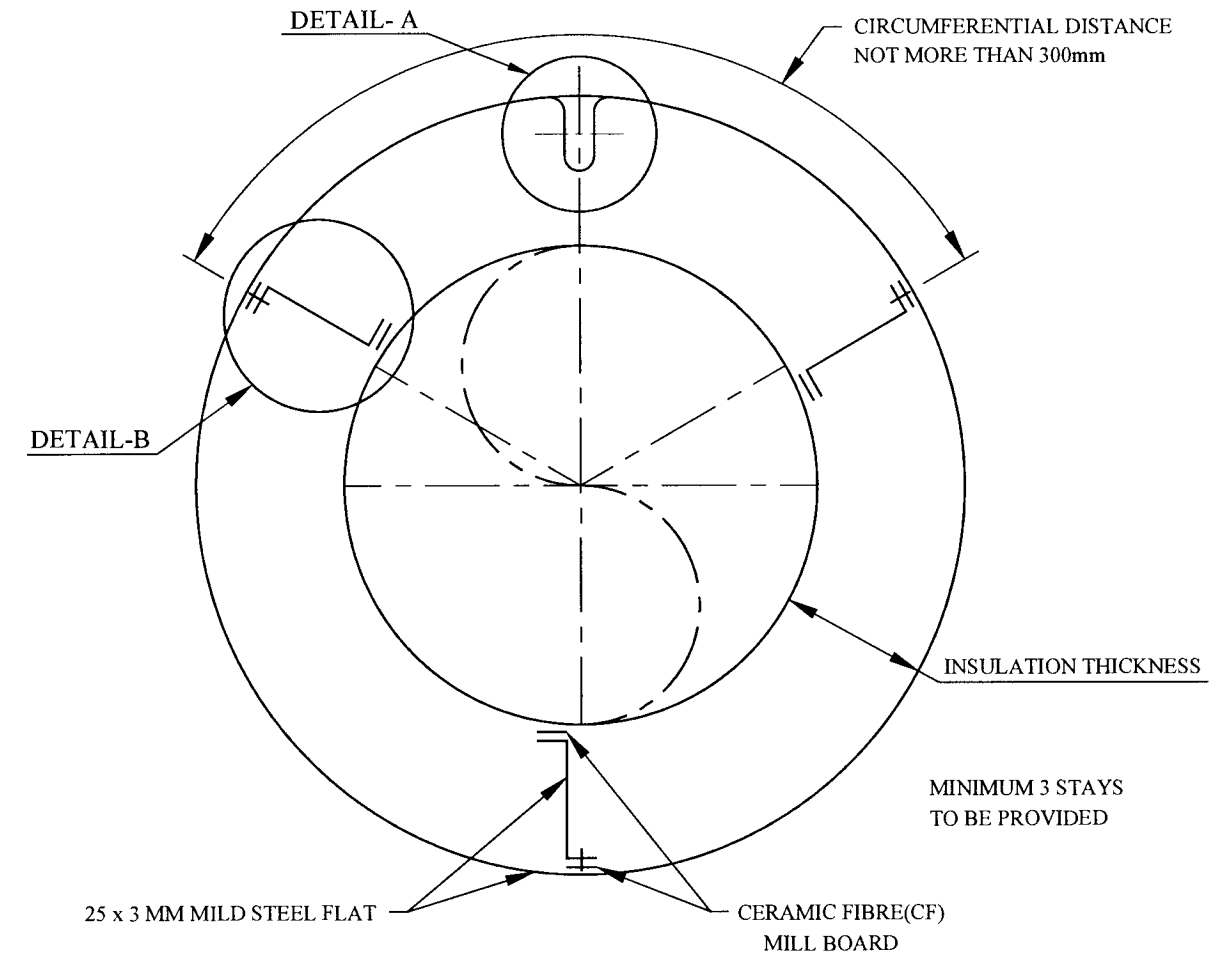
DRAWING NO.-10.4



SUPPORTS FOR BLOCK INSULATION
DRAWING NO.-11.1

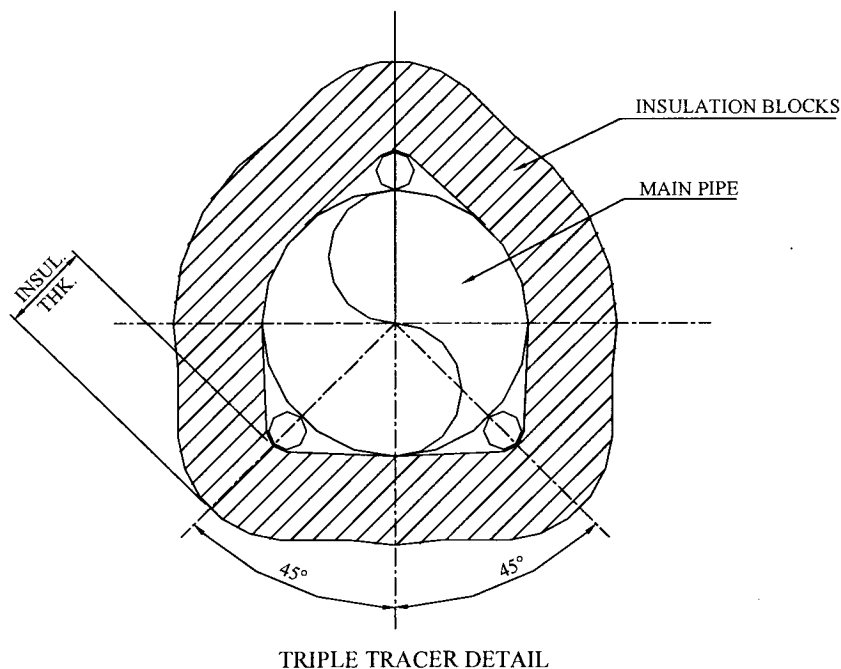
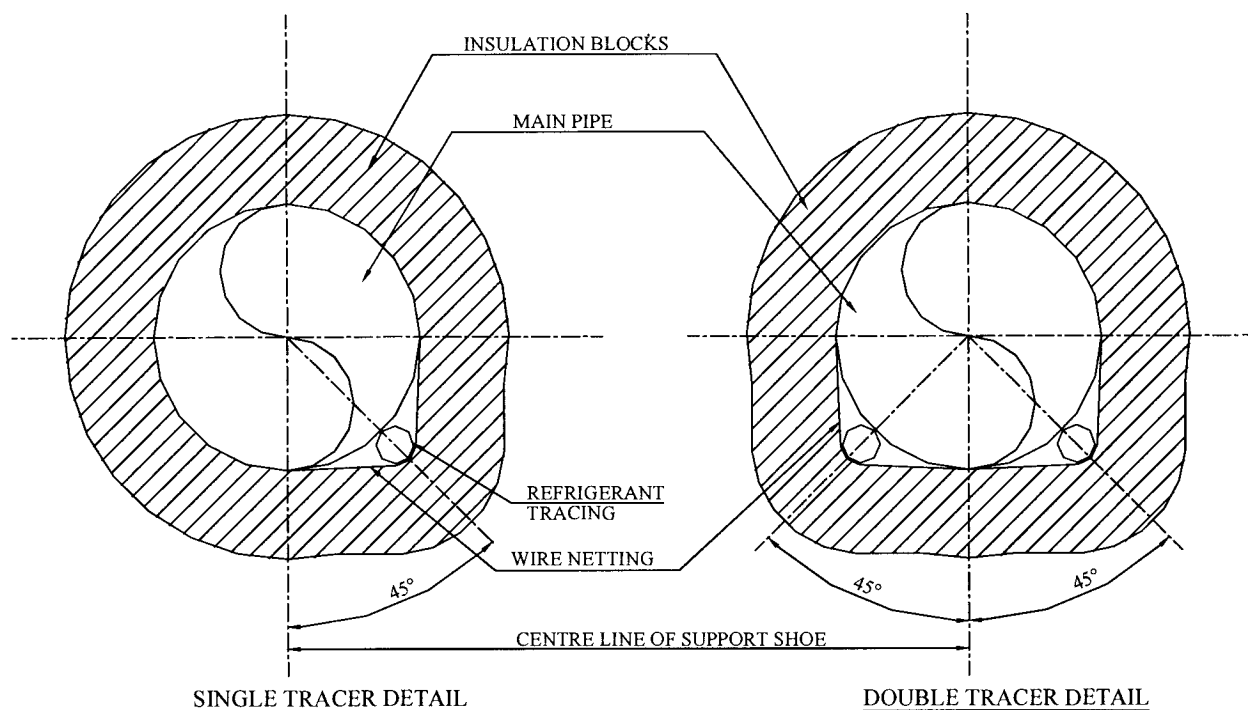


CLIPS ON HEADS AND INSIDE SKIRT FOR BLOCK INSULATION
DRAWING NO-11.2



DETAIL OF SPACER RING

DRAWING NO.-12



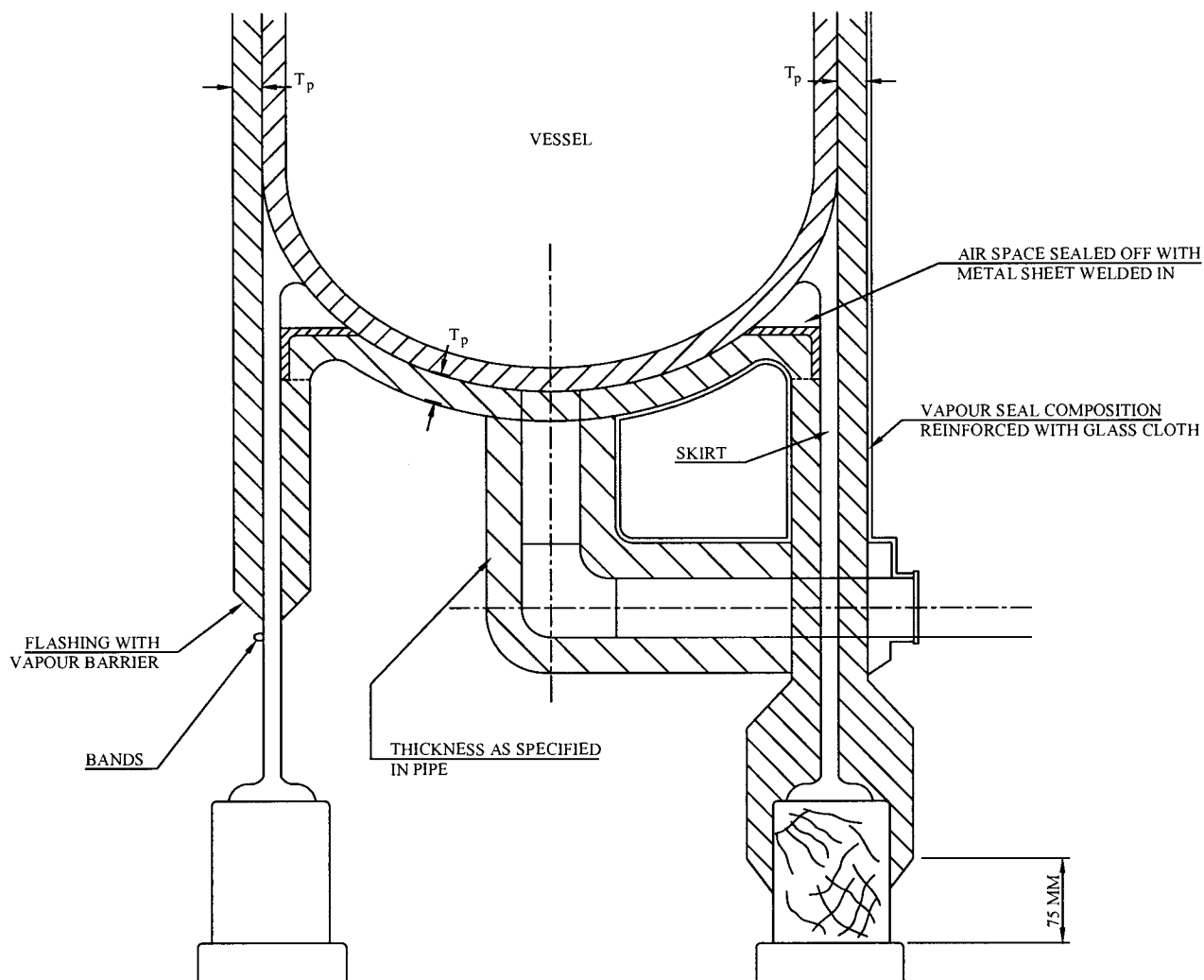
REFRIGERANT TRACING INSULATION

DRAWING NO.-13



DRAWING NO.-14.2

METHOD OF LAGGING FLANGED JOINTS OF VESSEL



WOOD BLOCKS TO BE COATED ALL OVER WITH ADHESIVE BEFORE ASSEMBLY

T_p = THICKNESS OF VESSEL INSULATION

NOTE : ALL CORNERS MUST BE ROUNDED MINIMUM RADIUS 25 MM

METHOD OF INSULATING VESSEL SKIRT

(ALTERNATIVE FOR HALF OR FULL INSULATION OF SKIRT)

DRAWING NO.-15